

**The invention claimed is:**

1. A system for tracking and regulating an optical  
2 beam, comprising:
  - a) at least one solid-state optical beam regulator;
  - 4 b) an optical sensing device;
  - c) a computer for calculating control signals using  
6 beam information from the optical sensing device.
2. The system of claim 1 wherein at least one beam  
2 regulator operates by refraction.
3. The system of claim 1 wherein at least one beam  
2 regulator is a stress-optic refractor.
4. The system of claim 1 wherein at least one beam  
2 regulator is capable of two-dimensional steering.
5. The system of claim 1 wherein the optical sensing  
2 device uses a portion of the transmitted beam reflected from  
the target as the beacon for tracking, steering and shaping  
4 the transmit beam.
6. The system of claim 1 wherein at least one beam  
2 regulator acts as a lens to re-focus the beam or return the  
beam to a collimated state.
7. The system of claim 1 wherein the system includes  
2 two one-dimensional stress-optic refractors in series.
8. The system of claim 1 wherein the optical sensing  
2 device is a CMOS imaging device.
9. The system of claim 1 wherein the optical sensing  
2 device senses a region of interest that is less than the  
total frame area, so as to perform at a faster frame rate,  
4 thereby allowing the device to respond to faster beam  
movements.
10. The system of claim 1 wherein the optical sensing  
2 device provides beam position and shape information to the  
computer and thence to the regulator at speeds greater than  
4 1 kHz and position accuracies better than 1 microradian.

11. The system of claim 1 wherein the computer  
2 receives information about the beam's position from the  
optical sensing device, calculates the beam's displacement  
4 from a reference position, and then sends steering signals  
to the beam regulator, so as to steer the beam toward the  
6 reference position.

12. The system of claim 1 wherein the computer  
2 receives information about the beam's size and shape from  
the optical sensing device, calculates the beam's deviation  
4 from desired collimation, and then sends shaping signals to  
the beam regulator, so as to shape the beam toward the  
6 desired collimation.

13. The system of claim 1 wherein the system steers  
2 the beam in two dimensions and at microradian accuracy.

14. The system of claim 1 wherein at least one beam  
2 regulator can function at frequencies greater than 1 kHz.

15. A system for tracking an optical beam and  
2 regulating an optical beam over a range of frequencies  
including frequencies greater than 1 kHz, comprising:  
4 a) at least one optical beam regulator;  
b) an optical sensing device; and  
6 c) a computer for calculating steering and/or shaping  
signals using beam information from the optical sensing  
8 device.

16. The system of claim 15 wherein at least one beam  
2 regulator operates by refraction.

17. The system of claim 15 wherein at least one beam  
2 regulator is a stress-optic refractor.

18. The system of claim 15 wherein at least one beam  
2 regulator is capable of two-dimensional steering.

19. The system of claim 15 wherein at least one beam  
2 regulator acts as a lens to re-focus the beam or return the  
beam to a collimated state.

20. The system of claim **15** wherein the system includes  
2 two one-dimensional stress-optic refractors in series.

21. The system of claim **15** wherein the optical sensing  
2 device is a CMOS imaging device.

22. The system of claim **15** wherein the optical sensing  
2 device senses a region of interest that is less than the  
total frame area, so as to perform at a faster frame rate,  
4 thereby allowing the device to respond to faster beam  
movements.

23. The system of claim **15** wherein the optical sensing  
2 device provides beam position and shape information to the  
computer and thence to the regulator at speeds greater than  
4 1 kHz and position accuracies better than 1 microradian.

24. The system of claim **15** wherein the computer  
2 receives information about the beam's position from the  
optical sensing device, calculates the beam's displacement  
4 from a reference position, and then sends steering signals  
to the beam regulator, so as to steer the beam toward the  
6 reference position.

25. The system of claim **15** wherein the computer  
2 receives information about the beam's size and shape from  
the optical sensing device, calculates the beam's deviation  
4 from desired collimation, and then sends shaping signals to  
the beam regulator, so as to shape the beam toward the  
6 desired collimation.

26. The system of claim **15** wherein the system steers  
2 the beam in two dimensions and at microradian accuracy so as  
to point the beam continuously at a distant receiver.

27. A method of optically communicating in free space  
2 for metropolitan access to optical fiber networks,  
comprising the steps of:

- 4 a) providing the system of claim **1**; and  
b) operating the system to track and regulate at

6 least one optical beam to provide duplex optical  
communications between sites separated by 200 to 1000  
8 meters.

28. A method of optically communicating in free space,  
2 comprising the steps of:

- a) providing the system of claim 1; and
- 4 b) operating the system to track and regulate at  
least one optical beam to provide communications between two  
6 sites, at least one of which is mobile.

29. A method of optically communicating in free space,  
2 comprising the steps of:

- a) providing the system of claim 1; and
- 4 b) operating the system to track and regulate at  
least one optical beam to provide communications between an  
6 earth-orbiting satellite and a ground station or between two  
earth-orbiting satellites.

30. A method of optically communicating in free space,  
2 comprising the steps of:

- a) providing the system of claim 1; and
- 4 b) operating the system to track and regulate at  
least one optical beam to provide communications between  
6 satellites in deep space wherein the reference beam may be a  
beacon from earth or a known planet or star.